 BFKЛ catch up!

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Outline

1. Introduction
2. Phenomenology
3. Theory
4. $\mathcal{N} = 4$ Supersymmetry
5. Summary

Please note

- no sharp distinction between the blocks
- I apologize for dropping and drastically condensing.
perturbative QCD = expansion in coupling $\alpha_s$

- large but ordered scales (e.g. $s \gg |t| \gg \Lambda_{\text{QCD}}^2$) $\Rightarrow$ large logs $(\log s/t)$ for each additional emission in multi Regge kinematics $\Rightarrow$ compensating smallness of $\alpha_s$

- need to resum terms $\sim (\alpha_s \log s/t)^n$
  $\Rightarrow$ LO Balitsky-Fadin-Kuraev-Lipatov equation ['75-'78]

- resummation of terms $\sim \alpha_s(\alpha_s \log s/t)^n$
  $\Rightarrow$ NLO BFKL equation ['98]
[Caporale, Papa, Sabio Vera]:\[\gamma^*\gamma^* \rightarrow VV\] at NLO BFKL with collinear improvement \(\rightarrow\) more 'sensible' energy scales

[Caporale, Ivanov, Papa]: \(\sigma_{\text{tot}}\) NLO BFKL Green’s function with (N)LO impact factor + quark box
**Forward Jets**

- [Chevallier, Kepka, Marquet, Royon]: Fwd jets with rapidity gap, NLO BFKL, good agreement with Tevatron data
- Mueller-Navelet jets
  - NLO BFKL Green’s function + LO vertices [Marquet, Royon; Sabio Vera, Schwennsen]
  - full NLO BFKL under work [Colferai, Schwennsen, Szymanowski, Wallon]
Discrete Pomeron

Talk by Douglas Ross
already well covered in this conference
Möbius Representation

- [Baltisky, Chrilli]: NLO evolution of color dipoles
  - for conformal invariance in $\mathcal{N} = 4$ counterterms are needed because of non-conformal regularization
- [Fadin, Fiore, Grabovsky, Papa]: NLO non-forward BFKL kernel in Möbius Representation
  - non conformal terms not only due to $\beta_0$
  - not unambiguously defined:
    $$(s_0, \hat{K}_{NLO} \to \hat{K}_{NLO} - [\hat{K}_{LO}, \hat{O}])$$
    $\to$ hope
- Now: agreement for forward BFKL
NLO BFKL not conformal $\Rightarrow$ LO eigen functions $(k^2)_{\gamma}$ are not eigen functions of NLO kernel, how to handle?

- eigenvalue $\omega(\gamma)$ becomes operator
- [Bondarenko]: $(k^2)_{\gamma} \rightarrow (k^2)_{\gamma} - \frac{\alpha_s \beta_0}{4\pi}$ conformal after expansion
- [Ross]: involved numerical estimation of NLO eigen functions
- no completely satisfactory solution so far
Not Quite Pigeonholable

- [Avsar, Hatta, Matsuro]: soft gluon away from jets in $e^+e^-$ annihilation related to BFKL equation in coordinate space
- [Motyka, Staśto]: exact kinematics in LCPT for dipole evolution
  $\leadsto$ suppression of large dipoles
  $\leadsto$ most singular terms of NLL reproduced

\( N = 4 \) SUSY

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Odderon

Solutions to the BKP-Equation at LO: JW-Odderon (intercept<1), BLV-Odderon (intercept=1)

- **[Braun]**: BLV-Odderon keeps intercept=1 if running copuling introduced via bootstrap relation
- **[Stašto]**: BLV-Odderon keeps intercept=1 beyond LO (using ω-expansion)
- **[Brower, Djurić, Tan]**: counterpart of Odderon in IIB on $AdS_5 \times S^5$: Kalb-Ramond field $B_{\mu\nu}$
  - also 2 Odderons in the strong t’Hooft coupling:
    \[
    \text{intercept} = 1 - \frac{m_{AdS}^2}{2\sqrt{\lambda}} + \mathcal{O}(1/\lambda), \quad \text{where } m_{AdS,1} = 0, \quad m_{AdS,2} = 16
    \]
- **[Bzdak, Motyka, Szymanowski, Cudell; Pire, Schwennsen, Szymanowski, Wallon]**: proposals to look for perturbative Odderon
Wrapping corrections in $\mathcal{N} = 4$ SUSY

Asymptotic Bethe ansatz [Beisert, Staudacher] for anomalous dimension expected to fail if perturbation order $\geq$ length of operator. Simplest example: Konishi operator wrapping corrections needed at $g^8$

- result has to meet pole structure of BFKL [Kotikov, Lipatov, Rej, Staudacher, Velizhanin] (’all order result!’)
- confirmed by [Fiamberti, Santambrogio, Sieg, Zanon; Velizhanin; Bajnok, Janik, Łukowski]
Bern Dixon Smirnov ansatz for MHV scattering amplitude
\[ A_n = A_n^{(\text{Born})} e^{M_n} \] misses terms for \( n \geq 6 \) [Drummond, Henn, Korchemsky, Sokatchev; Alday, Maldacena]

- [Bartels, Lipatov, Sabio Vera; Del Duca, Duhr, Glover; Brower, Nastase, Schnitzer, Tan] BDS does not reproduce MRK amplitude for \( n = 6 \), missing cut contribution

- en passant: ingredients for NNLO BFKL Kernel in \( \mathcal{N} = 4 \) assembled
more progress in $\mathcal{N} = 4$

- [Bartels, Mischler, Salvadore]: $R$-Current impact factors (as counterpart to $\gamma^*$-IF in QCD), starting point for more studies on Pomeron-Gravity duality

- [Bartels, Hentschinski, Mischler]: Triple-Pomeron vertex, ... more to come

- [Gómez, Gunnesson, Hernández]: more on connection between BFKL and spin chain (still many conjectures)
Summary

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Discrete Pomeron [Talk on Wednesday]

- Running coupling: series of Regge poles + fixed phase encoding IR behavior instead of Regge cut
- Work of [Ellis, Kowalski, Ross]: Fit of NLO renormalization-group-improved BFKL Pomeron to H1 data
- Good agreement already for 3 poles
- For a more realistic proton impact factor: need a lot of poles
Central In-/Exclusive Production

- [Levin, Miller]: background to inclusive $WH$ production
- [Andersen, Del Duca, White]: advanced FKL-based MC for inclusive Higgs production
- [Cudell, Dechambre, Hernández, Ivanov]: exclusive dijet production $\rightarrow$ dominated by non-perturbative region dominates

(Florian Schwennsen) BFKL catch up!